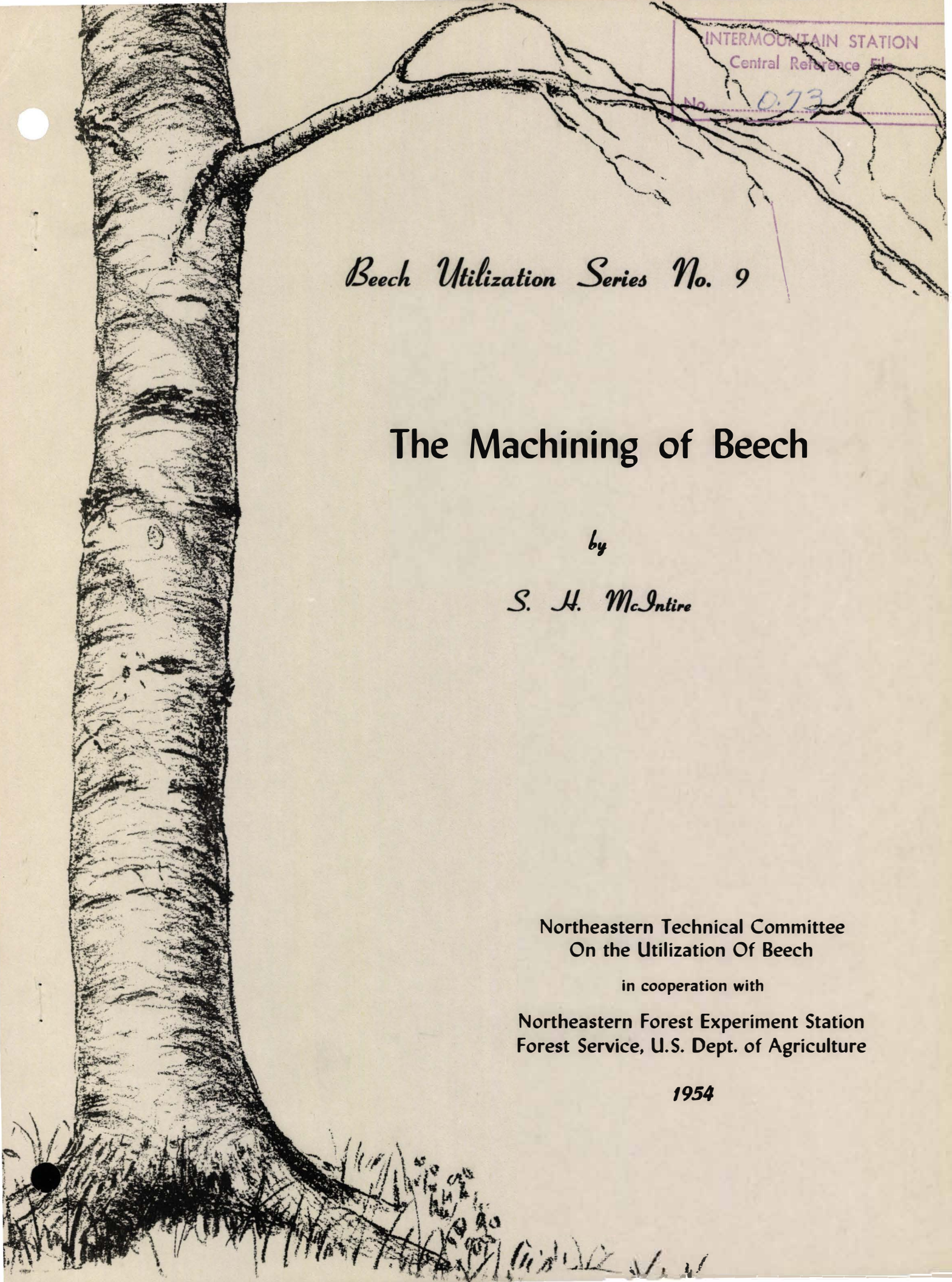

INTERMOUNTAIN STATION
Central Reference File
No. 0.73

Beech Utilization Series No. 9

The Machining of Beech

by

S. H. McIntire

Northeastern Technical Committee
On the Utilization Of Beech

in cooperation with

Northeastern Forest Experiment Station
Forest Service, U.S. Dept. of Agriculture

1954

FOREWORD

The wood of the American beech tree (Fagus grandifolia Ehrh.) is well suited for a large number of uses, and it is rather widely used by manufacturers. Yet the amount used is not in proportion to the amount that grows in our northeastern forests. The utilization of beech--both in the woods and in the factory--has been recognized as a problem.

One reason for this is in the nature of the wood: it has a reputation for being difficult to season. Another is that many of the beech trees in our forests are of poor quality. And there are some plain prejudices against beech.

Research is finding ways to utilize beech as efficiently as any of the other comparable hardwoods can be handled. Considerable information about beech has been gathered. Yet most of this information is available only in fragmentary form in scattered technical reports. Some of it has never been published.

To study the problems of putting beech to the uses it deserves, and to promote the better management of the forests in which it grows, a Northeastern Technical Committee on the Utilization of Beech was organized in 1949. This committee, which includes representatives of Federal and State forestry agencies, universities, and state experiment stations, decided to assemble and publish the available information about the utilization of American beech.

As its part of this cooperative project, the Northeastern Forest Experiment Station has undertaken to edit, publish, and distribute the series of reports that will contain this information.

The subjects of these reports will be as follows:

* Physical and mechanical properties of American beech.

(CONTINUED ON INSIDE OF BACK COVER)

THE MACHINING OF BEECH

by

S. H. McIntire

Vermont Bureau of Industrial Research
Norwich University, Northfield, Vermont

THE MACHINING OF BEECH presents no serious problems because of the nature of the wood. Assuming that the wood arrives at the saw, lathe, or planer with no imperfections from the drying process, the machining should cause no unusual trouble.

Anyone who is accustomed to working with birch and maple should be able to machine beech equally as well. For turnings especially, most operators believe beech gives a better surface than other competing woods.

In this report, the machining qualities of beech are compared with those of birch and maple. Unless otherwise stated, the data used come from two sources: a study of the machining characteristics of southern hardwoods, by E. M. Davis of the U. S. Forest Products Laboratory (1)[1]; and a survey of wood planing and turning practices in Vermont, made by McIntire and Davis for the Vermont Bureau of Industrial Research (3). The data collected by Davis are from experimental work. Those collected by McIntire are based on actual mill practice and experience.

---

[1] Underlined numbers in parentheses refer to Literature Cited, page 6.

PLANING

Few results of formal research have been published on the planing properties of beech. Trial-and-error methods and the experience of good woodworkers indicate that the general practice is to plane beech in the same way that birch or maple are planed.

Practically no operators change their machine operations for the three woods. This means that for a 4-knife cutterhead planer they would use a cutting angle[2] of 30°, a feed rate of 40 feet per minute, a cutterhead speed of 3,600 revolutions per minute, and a depth of cut of approximately 1/16 inch.

An angle of approximately 20° would undoubtedly give more defect-free pieces of hard wood. This is borne out by Davis (1) when he lists birch and maple as planing best at an angle of 20° or less. He gives no data on beech itself as far as angles are concerned; but at the 30° angle, beech planed somewhat better than did birch or maple. One of the planer manufacturers recommends an angle of 10° for beech, birch, and maple.

This cutting angle of 30° is used primarily because the standard planers are sold with the knife slots machined to hold the knife at this angle. With the angle of the knife set, the only way to get a smaller cutting angle is by back-bevelling the knife. This is an involved process that cannot be done with the knives in the machine as most regular grinding is done now. As a result, back bevelling is done by only a few operators. By this means, however, as small a cutting angle as wanted can be secured.

John E. Hyler says (2):

> Knives with a 15° back bevel will efficiently plane wet birch or beech, dry elm or gum, bone-dry hemlock, yellow pine or white pine. They are generally provided with a 40° included angle between their two bevels. Knives with a 20° back bevel are also given an ordinary bevel of 20°, the two bevels, thus giving a 40° included angle of steel left standing.... When a knife is given a 25° back bevel, it is often

---

[2]The cutting angle is the angle formed at the point of the knife by the edge of the knife and a line to the center of the cutterhead.

provided with a 20° ordinary bevel, so that it has an included angle of 45° of steel left standing at the knife edge. Dry birch and beech may be machined to advantage with such knives. Knives are occasionally back-bevelled so much as 30°, in which case they are used for bone dry stock of the most refractory types, including bone dry birch, beech, and maple.

Several manufacturers advertise that they will machine knife slots in a new planer to make any cutting angle required. The 30° angle apparently works well for most soft woods.

According to Davis, a moisture content of approximately 6 percent gives the smoothest results in planing beech, as for most other hard woods.

TURNING

According to experienced woodworking men, beech ranks near the top in desirable turning properties. Davis shows it gives 90 percent good to excellent turnings, exceeded only by black walnut at 91 percent. Maple gives 82 percent and birch 80 percent. Panshin (4) lists beech as the best wood of those produced in Michigan as far as turning qualities are concerned.

In Vermont the common practice among experienced woodworkers is to use the same angles and speeds for beech as they use for maple and birch. If they use an oil lubricant for maple, they often use it for beech. Unfortunately, there is little agreement about angles and speeds; and there is very little published material on the subject.

But there are a few points on which many operators agree. One is that turning speeds should be as great as safety and practicability will allow. This is borne out by Davis, who found that, up to the limit of his lathe, the results improved with higher turning speed. McIntire and Davis give, for example, turning speeds of 2,500 to 6,800 r.p.m., which correspond to peripheral speeds of 820 to 2,940 feet per minute.

It is exceedingly difficult to describe by words or drawings the angles used in grinding and setting knives in lathes. The best method of obtaining information on better techniques is to talk or work with an experienced operator

who is willing to share the results of his experience. The general conclusion drawn by McIntire and Davis is that

> "...in every case in which the knife was stationary..., the knife was set with its cutting edge directly in line with the center of rotation and with the flat side of the knife tangent to the radius of the piece being turned (a rake angle of 0^{o})."

The power requirements for beech are reported in several instances to be higher than for maple or birch.

SHAPING

The little information available indicates that beech lies about halfway down a table of hardwoods according to quality of shaped products. This is in the vicinity of soft maple, but considerably below hard maple and birch, which are near the top in this characteristic.

These tests were run by Davis on a spindle shaper turning at 7,200 r.p.m. The difference in smoothness was on the end grain. In view of the good turning properties of beech, it is strange that the results of the shaping tests were so poor. One woodworking firm, who work beech exclusively, believe that with sharp knives and 6 percent moisture content, beech is near the top as a wood for shaping.

BORING

Beech rates as one of the best species in regard to smoothness of drill cut in boring. Davis found that 99 percent of the holes he bored in beech were good to excellent in smoothness. This compared to 99 percent for hard maple and 98 percent for birch.

It should be remembered that in the harder woods, such as beech, the hole bored becomes smaller than the bit as the bit is withdrawn. Beech will sometimes produce a hole that is 0.002 inch smaller than the 1-inch bit that made it. Davis found the size of holes in beech became considerably smaller than those in hard maple or birch--an average of 0.001 inch shrinkage as compared to 0.0006 and 0.0004 inch. As long as this fact is realized before a fitting operation is carried out, it should not be a difficult problem.

Davis found the power consumption in boring beech to be only slightly greater than that needed for birch and hard maple. For a 1-inch hole, the wattages were 560 for beech, 520 for maple, and 500 for birch.

MORTISING

Here, as in boring, the properties of beech show up in the smoothness of the cut and the change in size of the opening. Beech is high on the list as far as smoothness is concerned, just under birch and hard maple; 93 percent fair to excellent mortises in a given test for beech, as compared to 95 percent for birch and 97 percent for maple.

However, it should be remembered that the size of the hole will be about twice as much off for beech as for birch and hard maple. In $\frac{1}{2}$-inch mortises, Davis found an average of 0.0044 inch undersize for beech, 0.0028 for birch, and 0.0021 for hard maple.

SANDING

Beech appears to present no special difficulties in sanding. In a test of resistance to scratching by 2/0 sandpaper, beech gave 14 percent scratch-free pieces as compared to 15 percent for birch and 0 for hard maple. In a test on freedom from fuzzing caused by sanding, beech gave 85 percent fuzz-free pieces as compared to 53 percent for birch and 76 percent for hard maple.

FREEDOM FROM SPLITTING

Beech is considerably better than birch and maple in its freedom from splitting when nails are driven into it or when screws are forced into it. None of the dense hardwoods are good in this respect, of course.

When nails were driven into samples, beech gave 42 percent split-free pieces, as compared to 32 percent for birch and 27 percent for hard maple. When screws were driven into bored holes that were too small for the screws, beech gave 58 percent split-free pieces, as compared to 52 percent for hard maple and 48 percent for birch.

CONCLUSIONS

In general, it appears that beech can be machined satisfactorily by the same techniques (speeds and angles) that are used for birch or maple. Under these conditions, good color, texture, and smoothness of surface can be expected.

Because of the tendency of beech to change size slightly after machining, beech is probably not so good as birch or maple for high-precision turnings and for small turned parts that might be passed through a die in the process of manufacture.

For turnings, beech is equal to or superior to birch or maple. A usual reaction among experienced operators is, "Given the same grade or price or number of defect-free pieces of stock as we get of birch, we would use birch and beech interchangeably."

The problem with beech appears to be to improve the drying schedules in general use and to break down the prejudices among woodworkers caused by the poor results of drying procedures used in the past.

LITERATURE CITED

(1) Davis, E. M.
1942. MACHINING AND RELATED CHARACTERISTICS OF SOUTHERN HARDWOODS. U.S. Dept. Agr. Tech. Bul. 824. 42 pp., illus.

(2) Hyler, John E.
1950. WOODWORKING KNIFE AND CUTTER APPLICATION, PART II. South. Lumberman 180 (2257): 62, 64, 66.

(3) McIntire, S. H., and Davis, E. M.
1949. SURVEY OF WOOD PLANING AND TURNING MACHINERY IN VERMONT. Vt. Bur. Indus. Res. 11 pp., illus. (Norwich University, Northfield, Vt.)

(4) Panshin, A. J.
1947. THE MICHIGAN WOOD TURNING INDUSTRY. Mich. Dept. Econ. Devlpmt., Forest Prod. Res. Com. Pub. 4. 27 pp.

(CONTINUED FROM INSIDE OF FRONT COVER)

* Chemistry and chemical utilization of beech.
Management of beech.
Beech availability and supply.
Present markets and uses for beech.
Methods of logging beech.
Seasoning of beech.
* Storage of beech logs and bolts.
* Machining of beech.
Milling of beech.
* Gluing techniques for beech.
* Steam-bending of beech.
Preservative treatment of beech.
* Beech for flooring.
Beech for furniture.
Beech for turned products and novelties.
* Beech for veneer and plywood.
Beech for fuel and charcoal.
Beech for cross ties.
* Beech for containers.
Pulping and defiberization of beech.
Rough construction on the farm with beech.

The Northeastern Station acknowledges gratefully the effort being devoted to these problems by the many agencies and individuals who are cooperating in this project. Among the leaders in it are David B. Cook, New York State Conservation Department; Claude Bell, U.S. Forest Products Laboratory; A. H. Bishop, State University of New York, College of Forestry; and Fred Wangaard, Yale University School of Forestry. These men, along with Fred C. Simmons and C. R. Lockard of the Northeastern Station, comprise the "working committee" that is directing and coordinating the project.

The information gathered in this widespread cooperative project should be of great use to the wood-using industries of the regions where the wood of American beech is available.

Ralph W. Marquis

Ralph W. Marquis, Director
Northeastern Forest Experiment Station
102 Motors Avenue, Upper Darby, Pa.

---

*Reports published.